Renewable and Sustainable Energy Reviews 27 (2013) 654–663

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

Renewable Energy Certificates (RECs) in India – A performance analysis and future outlook

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ARTICLE INFO

Article history:
Received 21 June 2012
Received in revised form
2 April 2013
Accepted 20 July 2013
Available online 8 August 2013

Keywords:
Renewable energy certificates (RECs)
Renewable purchase obligations (RPOs)
Market mechanism
Energy exchange

ABSTRACT

Well designed Renewable Energy (RE) policies and their effective regulation is the key to promote RE generation in the world. Renewable Energy Certificate (REC) mechanism is a market-based policy instrument which facilitates Renewable (Energy) Purchase Obligations (RPOs) in order to increase RE generation in a country. The recently conceived and implemented REC mechanism in India attempts to involve various stakeholders in an economically efficient manner and has been effective in its first year of operation. The paper commences with the background and the genesis of REC mechanism in India. It characterises the REC trading mechanism and analyses the performance of the REC market for the FY 2011–12. Comparing the financial viability for sale of RE by project developers in certain key states, the paper shows that REC mechanism is more profitable than entering into a Power Purchase Agreement (PPA) for sale of RE at Preferential Tariff (Feed-in-Tariffs). Thus, the REC market which has attained a size of 2.3 billion INR in its first year of existence is forecasted to grow manifold in the future and the paper attempts to forecast the market size in near term. Further analysis of the REC market reveals that although there are inherent advantages of the REC mechanism over other methods of promoting growth of RE, the market is currently subject to various distortions and the paper suggests few steps for correcting these distortions by appropriate market re-design. The paper concludes that the REC market mechanism has gained momentum and can effectively promote RE generation in an economically efficient manner, with benefits to all stakeholders, provided it is strictly implemented and continuous corrections are given in the right direction by the market regulator.

Contents

1. Introduction . . . 655
2. REC mechanism . . . 655
   2.1. Rationale behind the REC mechanism . . . 655
   2.2. REC scheme in brief. . . . 655
   2.3. Conceptual framework . . . 656
3. Objective . . . 656
4. Methodology . . . 656
   4.1. The paper adopts the following methodology.. . . . 656
5. Calculations and analysis. . . . 656
   5.1. First year of REC mechanism. . . . 656
      5.1.1. Projects under REC scheme . . . 657
      5.1.2. Demand and supply side drivers of REC mechanism . . . 657
   5.2. Financial assessment of options for RE generators: 2011–12 . . . 658
   5.3. REC market analysis . . . 658
      5.3.1. Trading data . . . 658
      5.3.2. Trading data analysis . . . 659
6. Results: future outlook for REC market . . . 659

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1364-0321/$ - see front matter
http://dx.doi.org/10.1016/j.rser.2013.07.040

6.1. Trends in addition of RE generation capacity . . . 659
6.2. Forecast of installed RE generation capacity . . . 659
6.3. REC market forecast . . . 660
7. Discussion . . . 660
7.1. Advantages and disadvantages of REC mechanism . . . 660
7.2. Correcting market distortions . . . 661
7.2.1. Steps to increase supply of REC . . . 661
7.2.2. Increasing demand of REC. . . . 661
7.2.3. Reduce pricing risk . . . 661
7.3. Contribution of REC mechanism to RE development in India . . . 662
8. Conclusion . . . 662
Acknowledgements . . . 663
Appendix A. . . . 663
References . . . 663

1. Introduction

Renewable Energy Certificate (REC) mechanism is a market-based policy instrument and it has been used effectively to promote growth of Renewable Energy (RE) under a supportive policy and regulatory regime in Australia, Sweden, Italy, Germany and UK. It is estimated that the midterm potential (till 2032) of RE (excluding solar) in India is in the range of 85,000–90,000 MW [1] and the total potential of RE is in the range of 152,000–172,000 MW [2]. However, as on 30 Apr, 2012 only 25,018 MW [3] of installed capacity (grid interactive) of electricity generation was from RE sources, which was 10% of the total installed electricity generation capacity in the country. Given the significant renewable energy (RE) potential in India, there is a tremendous opportunity for growth if the right impetus is given to harness RE resources.

Electricity generation from RE is relatively more expensive than generation by conventional means such as coal and hydropower. Hence, various policies are implemented by countries to make electricity generation from RE financially attractive, so as to encourage investment from private players in the RE sector. Generation of electricity from RE can be enhanced in primarily three ways viz. by providing financial incentives which are investment based or production based and having a supporting legal or regulatory framework. Investment based financial incentives are proportional to capital expenditure and include accelerated depreciation, sales tax and central excise tax exemption, reduced VAT, loan guarantees, investment tax credit, subsidies, income tax holidays (5–10 years), concessional import duties, long term land lease and soft loans [4]. On the other hand, there are production based financial incentives which are proportional to the energy generated. These include minimum feed-in-tariff and generation based incentives (GBIs), production tax credits, low power wheeling charges, banking of power, electricity duty and state sales tax exemption [5]. Some of these financial incentives like subsidies do place an additional burden on the state exchequer but are essential to kick start the investment in RE technology deployment. Other enablers which have been implemented in India to stimulate the RE sector include permission to invest 100% Foreign Direct Investment (FDI) in RE generation projects, providing infrastructure and preference to off take electricity generated from RE and options to earn carbon credits under Clean Development Mechanism (CDM) for GHG mitigation. Apart from these 'pull factors' there are regulatory approaches which include setting of mandatory Renewable Purchase Obligations (RPOs) which act as push factors to encourage the growth of RE.

2. REC mechanism

Although India has a significant RE potential, RE sources are distributed non-uniformly in India. The REC mechanism was therefore specifically conceived and implemented in order to overcome the limitation of uneven distribution of RE sources across the country. The process for accreditation of RE projects under this mechanism commenced on 18 Nov, 2010 and the first trading session of REC was conducted on 30 Mar, 2011. REC mechanism as a measure to promote RE generation in the Indian context has been discussed by Refs. [6–9]

2.1. Rationale behind the REC mechanism

Section 86(1) (e) of the Electricity Act, 2003, mandates State Electricity Regulatory Commissions (SERCs) with the function of RE promotion within the state[1]. SERCs set targets for Obligated Entities (OEs)[2], to purchase certain percentage of their total annual power requirement from RE sources. This target is termed as Renewable Purchase Obligation (RPO) and it has partially succeeded in creating a demand for RE through an RPO framework in India. However, it was noted that although SERCs had set RPO targets since 2005, the regulations 'did not' recognise purchase of RE from outside the state for fulfillment of RPO targets. Consequently, the states with low RE potential kept their RPO target at lower level. On the other hand, states which had high RE resources also set lower targets as the cost of procurement of RE, being higher than generation of conventional energy, lead to higher tariffs in states, which had to be absorbed by the State Electricity Boards (SEBs). Thus all states were limiting themselves to meet their RPO obligations only, which were deliberately set at a lower level in the first place. This was limiting the growth of RE generation capacity in the country which grew from 1806 MW (1.48% of total installed electricity generation capacity) in 2001–02 to 8136 MW (5.26%) in 2006–07 [10]. This necessitated the need for introduction of a market-based mechanism like RECs, which does not recognise geographical or physical boundaries and facilitates inter-state transaction of RE with least cost and technicality. With the REC mechanism in place, SERCs can now raise the RPO targets for OEs even if necessary RE resources are not available in the respective states.

2.2. REC scheme in brief

The concept of a framework for REC was evolved by the Forum of Regulators (FORs) and 'Terms and Conditions for recognition and issuance of RECs for Renewable Energy Generation' were issued as CERC Regulations, 2010 on 14 Jan, 2010. According to the scheme, SERC will define the RPO for every state based on their potential for generation of electricity from RE sources e.g. "Every OE shall purchase

[1] There are 28 States, 6 Union Territories and 1 National Territory in India.
[2] OE comprise of distribution licensees, open access consumers and captive power plant (CPP).

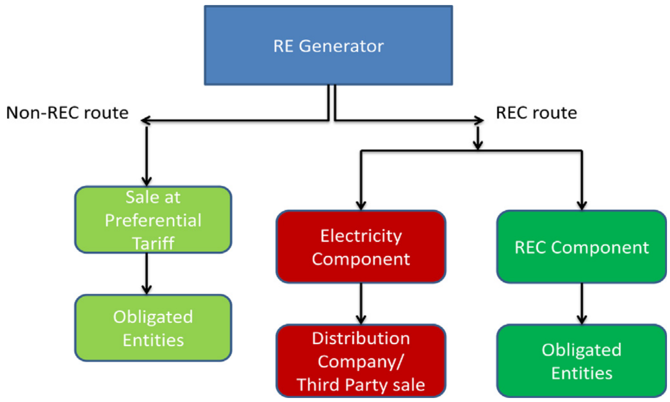


Fig. 1. Conceptual framework of REC scheme [12].

not less than … (%) of its consumption of energy from RE sources under the RPO during each of the years from … to ….” [11]. Thereafter, it is the responsibility of OE to purchase the minimum level of power from RE sources or REC[3], as defined by SERC. If the OE do not fulfill the RPO, during any year and also do not purchase the RECs, they have to deposit an amount (based on the forbearance price) on the basis of the shortfall in units of RPO into a separate fund. This fund will then be utilised, for purchase of the RE certificates. Hence the scheme is designed to give an incentive to the RE producers to generate power over and above the minimum targets set by the state and accumulate REC which can be then traded at an appropriate market driven price.

2.3. Conceptual framework

The conceptual framework of the scheme is briefly presented in Fig. 1.

The cost of electricity generation from RE sources is classified as cost of electricity generation equivalent to conventional energy sources and the cost for environmental attributes. As shown in Fig. 1, the RE generators will have two options – either to sell the RE at preferential tariff fixed by the concerned SERC or to sell the electricity generated and environmental attributes associated with RE generation separately. The environmental attributes can then be exchanged in the form of RECs. The RE generator may sell the ‘electricity component’ to the distribution company and ‘REC component’ separately to the OE in or outside the state. Grid connected RE Technologies with minimum capacity of 250 kW and approved by Ministry of New and Renewable Energy (MNRE) would be eligible under this scheme. RE generators with existing Power Purchase Agreements (PPAs) and RE sale at preferential tariff are not eligible for REC mechanism. As the compliance cycle for RPOs coincides with the financial year, we analyse the first year cycle of the REC mechanism using trading data for Apr 2011 to Mar 2012. Further, we focus our analysis to only non-solar RECs which have been traded in the last Financial Year (FY).

3. Objective

The aim of this paper is to present an outlook of REC market in the backdrop of past trends and planned targets for RE generation in India. In order to achieve this objective, the following are undertaken:

(a) Analysis of the demand and supply drivers for the first year of REC mechanism (Apr 2011–Mar 2012).

(b) Financial assessment of various options for sale of RE under the REC mechanism and its comparison with the existing schemes.

(c) Analysis of trading data viz. Market Clearing Volumes (MCVs) and Market Clearing Prices (MCPs) on energy exchanges to derive trends which are then used for forecasting the growth of supply and demand in REC market in near term.

Section 4 presents the methodology to accomplish the objectives. Section 5 undertakes an analysis of the performance of the first year of the REC mechanism and trading in the REC market. Section 6 presents the results using scenario analysis and forecasts the size of the REC market based on derived trends. Section 7 discusses the advantages and disadvantages of the REC mechanism over other methods and proposes certain recommendations for correcting market distortions before concluding in Section 8 that, a buoyant and growing REC market in the near future can effectively promote RE generation in an economically efficient manner.

4. Methodology

4.1. The paper adopts the following methodology.

(a) The paper analyses the demand and supply drivers to derive the trends which are used for forecasting the growth of supply and demand in REC market. To evaluate these trends it identifies the top 5 states which contribute to RE supply (in terms of RE capacity registered under the REC scheme) and RE demand (for fulfilling the RPO under the REC mechanism) and the share of various RE sources to the REC portfolio. These states will account for a major share of the demand and supply of RE and will therefore be pivotal for the success of REC mechanism in India.

(b) In order to undertake a financial assessment of various options for sale of RE under the REC mechanism for the year 2011–12 (undertaken for top 5 states which are generating RE), the paper identifies the % increase in profit for the RE developer when he sells the generated RE under the REC route as compared to other existing options for sale of RE. As the RE project developer will be keen to maximise his profit, it is very likely that he will opt for the REC mechanism if the scheme offers a higher profit.

(c) To analyse the trading data, weighted average of MCV and MCP of one full year of trading cycle on two energy exchanges is used to draw inferences for forecasting the MCV and MCP in near term.

(d) The paper then forecasts the REC market volume and market size using three scenarios where growth rate of installed capacity of RE and REC price is fixed while Capacity Utilisation Factor (CUF) for plant and share of RE under REC scheme is varied (based on the derived trends). This leads to a reliable forecast on the range of REC market size for the next 5 years from 2012 to 2017.

5. Calculations and analysis

5.1. First year of REC mechanism

This section presents some salient data on RE projects in the first year of REC mechanism viz. Apr 2011–Mar 2012. The entire data for REC mechanism is compiled by REC Registry of India and data for this section had been compiled from the sources available on website of REC Registry [13].

[3] 1 REC is equal to 1 MWHr and was designed to fall in the price range of Rs. 1500–3900 per REC for the FY 2011–12.

5.1.1. Projects under REC scheme

Table 1 presents the accredited and registered capacity of RE projects under the REC mechanism (top 5 states in detail) in the time period under analysis.

Fig. 2 complements Table 1 with the data on number of projects under the REC mechanism. As per the rules of the REC mechanism a project can be accredited upto 6 months in advance of its anticipated date of commissioning by the state designated agency and is thereafter registered on its recommendation by National Load Dispatch Centre (NLDC) upto 3 months prior to its anticipated date of commissioning. This explains the difference in aggregate capacity of registered and accredited projects. It is also seen that around 90% of the new RE projects are in the top 5 states and we can conclude that these states will lead the RE drive in India.

Fig. 3 presents the data on the capacity of RE projects registered under REC mechanism, as per different energy sources for various states. Fig. 3 reveals that Uttar Pradesh (UP) and Chhattisgarh only has cogen and biomass based projects while Maharashtra, Gujarat and Tamil Nadu (TN) primarily have wind based projects.

Table 1
Accredited and registered RE projects under REC mechanism.

	Accredited capacity (MW)	Registered capacity (MW)
Uttar Pradesh	683.13	657.73
Maharashtra	681.31	543.69
Tamil Nadu	560.90	531.25
Gujarat	290.65	215.05
Chhattisgarh	103	91.5
Others	276.05	246.95
Top 5 states combined	2318.99	2039.22
Total	**2595.04**	**2286.17**

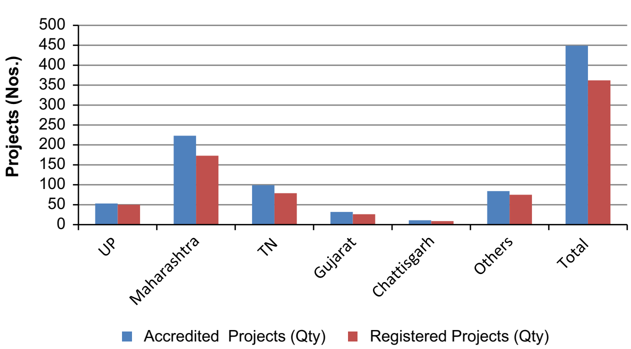


Fig. 2. Number of projects under the REC mechanism.

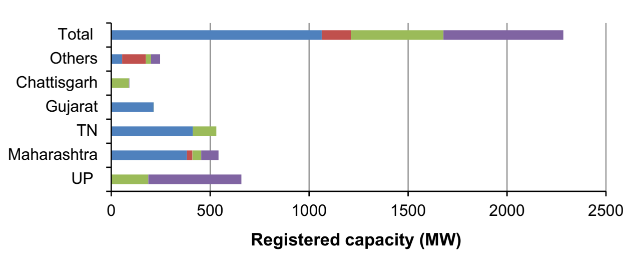


Fig. 3. State-wise capacity (in MW) of registered projects as per different RE sources.

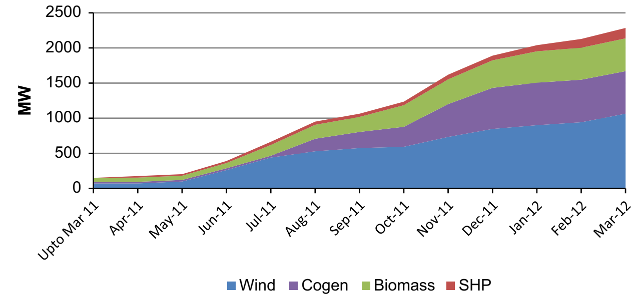


Fig. 4. Month wise capacity addition for registered projects as per RE source.

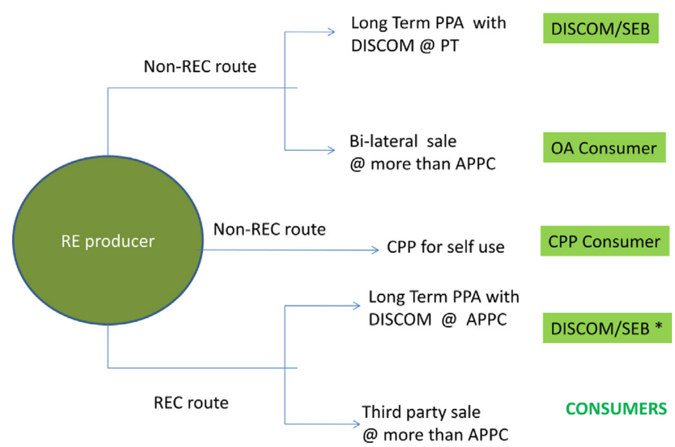


Fig. 5. Options for RE developer and OE for fulfilling RPO.

Fig. 4 shows the month wise capacity addition for registered projects for various RE sources. Fig. 4 reveals that although the registration of RE projects in the REC mechanism was relatively slow during the commencement of the scheme, it has picked up momentum in the latter half of the cycle which shows growing investor confidence in the REC mechanism.

5.1.2. Demand and supply side drivers of REC mechanism

The obligated entities (OEs) form the demand side of the picture. As per the RPO regulations of various states, there are three classes of consumers who need to purchase RE equivalent to a specified % of their total energy consumed. These are Distribution Companies (DISCOMS), Open Access consumers above 1 MW (OA) and grid connected Captive Power Producers (CPPs) above 5 MW. These consumers can purchase energy generated from renewable sources directly from the RE generator or they can purchase only REC certificates from the market to fulfill their RPO. Table A1 in Appendix A shows the likely power generated (as per 17th EPS [14]), RPO adopted by SERCs of the states and the respective calculated RE required for various states. The top 5 states which have high demand of RE are Maharashtra, Tamil Nadu, Gujarat, Karnataka and Andhra Pradesh. It can be therefore concluded that these states with a cumulative demand of 24,955 MU (approximately 58% of total all-India demand) will be the demand drivers of the growth of RE sector.

A careful look at the state determined RPOs reveal that the major burden of purchase of REC will have to be borne by the open access and captive consumers. This is primarily because, the state DISCOMs already purchase a significant amount of RE directly from RE generators at preferential tariffs and the RPO set by the states have been set such that they are marginally higher than the current purchases. Moreover, most of the state owned DISCOMs are suffering from poor financial health and trading data on power

Table 2
Financial assessment of options for sale of RE by project developer.

	Gujarat	Maharashtra			Chhattisgarh	Tamil Nadu		Uttar Pradesh	
	Wind	**Wind**	**Bio-mass**	**Bio-fuel/cogen**	**Bio-mass**	**Wind**	**Bio-mass**	**Bio-fuel/cogen**	**Bio-mass**
PT	4.63	4.63	4.31	4.34	4.41	3.95	4.58	4.76	4.06
PPC	2.7	2.85	2.85	2.85	2.15	2.69	2.69	2.75	2.75
Average REC price	2.34	2.34	2.34	2.34	2.34	2.34	2.34	2.34	2.34
Additional GBI for wind	0.5	0.5	–	–	–	0.5	–	–	–
PT (with GBI)	5.13	5.13	4.31	4.34	4.41	4.45	4.58	4.76	4.06
APPC (with GBI) and REC	5.54	5.69	5.19	5.19	4.49	5.53	5.03	5.09	5.09
% increase in profit (%) (PT VS APPC and REC)	7.99	10.92	20.42	19.59	1.81	24.27	9.83	6.93	25.37

exchanges reveal that they have not purchased any REC till date. Thus we can forecast that they might not participate in REC markets at least in the short term. On the other hand, captive consumers are likely to be significant participants on the REC markets both from the demand side as well as the supply side. Captive generation from non-utilities contributed to 15.9% of the total electrical energy in India in 2008–09. Most of this is from conventional fossil fuels and therefore these would emerge as major consumers of RECs. On the other hand, bagasse and biomass based captive power plants would also emerge as significant producers of RECs as they can now earn windfall profits from selling excess electricity and associated RECs from their cogen based plants separately. Demand from OA consumers is likely to be less, primarily as OA consumers currently transact a very small percentage of electricity on the exchanges for their needs. However, this segment of the market is likely to grow in near future as and when open access actually becomes more competitive and without barriers in reality.

Refer to Fig. 5 which shows various options for RE developer and OE for fulfilling their respective RPOs. The supply side of the picture comprises of RE producers who have projects registered under the REC mechanism and generate RE from approved RE sources. Prior to the introduction of REC scheme, most of the RE generators were selling 'green electricity' by entering into long term Power Purchase Agreement (PPA) with the distribution licensee at state regulated Preferential Tariff (PT) which ensured pre-determined cash flows for them. They could also sell RE to OA consumers through bi-lateral sale which could be concluded at a rate more than the Average Power Purchase Cost (APPC)[4]. With the introduction of REC mechanism, the RE generator now has the option of earning additional revenue via RECs by selling physical electricity and the environmental attributes of generated electricity separately. Now, they can sell electricity to the Distribution Company (DISCOM) @ APPC or in the form third party sale/bilateral contracts at mutually agreed prices to other OA consumers at and can simultaneously avail monetary benefits from sale of REC. Lastly, if the RE generator is a CPP, it can consume the energy generated for self use.

5.2. Financial assessment of options for RE generators: 2011–12

Table 2 compares various options available for the RE developer for sale of RE for newly commissioned projects in the top 5 states [15]. As shown in the last row of Table 2, the RE developer earns a higher profit per unit of RE injected into the grid if he exercises the option of availing PPA at APPC and can earn additional revenue from the sale of REC, as compared to PPA at Preferential Tariff rates

[4] Average Power Purchase Cost means *'the weighted average pooled price at which the distribution licensee has purchased the electricity including cost of self-generation if any, in the previous year from all the energy suppliers, but excluding those based on liquid fuel, short term purchases and renewable energy sources'*.

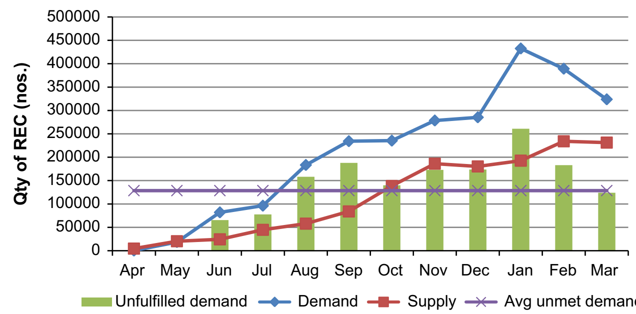


Fig. 6. Demand, supply and unmet demand of RECs.

with the DISCOM. The increase in profit is as large as 24% in the case of wind for the state of Tamil Nadu and the separate sale of REC is always more profitable for the RE developer. We can therefore conclude that the REC mechanism is therefore much more attractive for the RE generators and is now the preferred route for RE developer, as seen by the registration of new RE projects with NLDC.

5.3. REC market analysis

This section presents an analysis of trading data of REC market for the compliance year FY 2011–12 [13]. RECs can be traded only on two energy exchanges viz. India Energy Exchange (IEX) and Power Exchange India Limited (PXIL), both of which simultaneously conduct an online trading session on last Wednesday of each month for buying and selling of RECs. RE developers who have earned RECs put in a "sell" bid at a predetermined price and OE who want to buy RECs put a "buy" bid. As the process of price discovery is based on economics of demand and supply, the MCP is different on different exchanges. From the past 1 year data, it has been observed that IEX has maintained a market share of approximately 90% in the trading sessions over the last compliance year. As the market is currently very shallow in terms of traded quantities of RECs we use the compiled data of Market Clearing Volumes (MCVs) and MCP of both the exchanges for our analysis.

5.3.1. Trading data

The last trading session which marked the completion of one full cycle of REC trading (in conjunction with the RPO) compliance period was conducted on 28 Mar, 2012.

Fig. 6 shows the month-wise demand, supply, uncleared demand and average unmet demand of RECs for the period under consideration. The average unmet demand is derived by aggregating the monthly unfulfilled demand for the entire year and represents the shortage of supply of RECs when divided over a 1 year cycle. Fig. 7 shows the weighted (for both exchanges) average

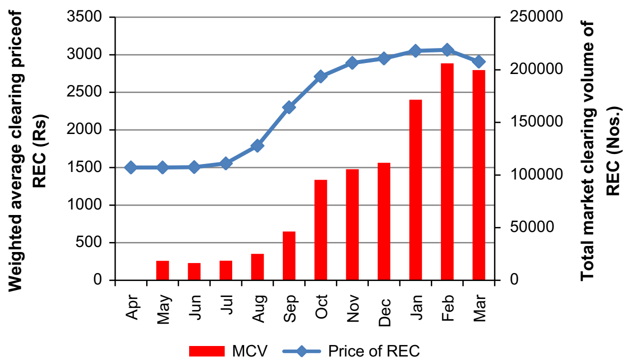


Fig. 7. MCV and MCP of REC.

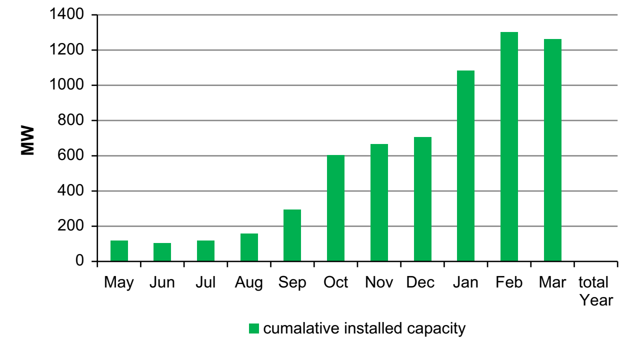


Fig. 8. Estimated month wise cumulative installed capacity of projects in REC mechanism.

market clearing price and total market clearing volume of REC for the months of Apr 11–Mar 12.

5.3.2. Trading data analysis

Following inferences can be drawn from the above data.

(i) As shown in Fig. 6, demand for REC exceeds supply throughout the year (except for Apr 2011 and May 2011, which can be attributed to start up phase of the scheme). Analysis of MCV in Fig. 7, in the backdrop of the annual compliance period reveals that the MCV is smaller in the first half of the year and is relatively higher in the second half of the year, peaking in Feb 2012.

(ii) Assessment of sell bids also reveals that more number of REC have come in the market in the second half of the FY which may be attributed to commissioning of new projects in response to the growing demand and growing confidence in the REC mechanism. A seasonal pattern is also likely to affect the supply of REC in the market as wind and small hydro peak during and after the monsoon season, while biomass and bagasse based RECs are linked to the harvesting season.

(iii) As seen in Fig. 6, the supply – demand gap peaked in Jan and reduced in Feb–Mar as the compliance period draws to a close and there is an average monthly deficit of 128,664 RECs in the market. Thus, we can safely assume in the backdrop of all India supply and demand scenario of RE that REC market will be a seller's market in the next few years.

(iv) Analysis of MCP from Fig. 7 reveals that REC prices traded near to floor prices of Rs. 1500 per REC from Apr to July and rose steadily thereafter from Aug to close around Rs. 2900 per REC in Mar 2012. It has been bound in the range of Rs. 2900–3065 since Nov to Mar 12. The average weighted price of REC over the year was Rs. 2907, which is greater than the mean (Rs. 2700) of floor (Rs. 1500) and forbearance price (Rs. 3900).

6. Results: future outlook for REC market

This section presents a forecast of the REC market based on the trends and analysis of market data for the past 1 year. Using these trends, we arrive at various assumptions and thereafter work out different scenarios to forecast the growth of REC market in the short term till 2016–17.

6.1. Trends in addition of RE generation capacity

Using the compiled data on sell bids, MCV of RECs for each month and a CUF of 22%, we estimate the cumulative installed capacity of projects which have been generating REC over the year. This is shown in Fig. 8.

Table 3
Key assumptions for forecasting the growth of REC market.

	Growth rate of installed capacity (2)	CUF (3)	Share of REC (4)	REC price (5)
Pessimistic (lower limit)	10%	20%	25%	Rs 1500
Likely	15%	22%	35%	Rs 2820
Optimistic (upper limit)	20%	24%	45%	Rs 3300

As shown in Fig. 8, the cumulative capacity in end Mar 2012 from REC route is approximately 1300 MW which is 24% of the total RE capacity addition of 5340 MW (estimated from own calculations) in 2011–12. It is interesting to note that although 2300 MW of projects had been registered in the REC mechanism, only 1300 MW projects were estimated to be generating RE and earning RECs in the considered time period, possibly due to commissioning delays and a time lag of around 3 months between registration of a project and its commissioning. We can infer from the above data that the share of projects actually earning RECs is 24.3% of the total estimated capacity addition of 5340 MW in FY 2011–12 which could be upto 45% if all REC projects which were actually registered would have commenced operations.

Table 3 presents the key assumptions used for forecasting the pessimistic, optimistic and likely case for the growth of REC market. Column (2) indicates the Annual Growth Rate (AGR) of installed capacity of RE. Trends of past data reveals that the 3 year moving average of the AGR of capacity addition of RE in India has been around 17.5% in 2010–11 and is expected to be 20.6% in 2011–12. However, the MNRE targets for annual installed capacity addition for 2012–13 to 2016–17, equate to 13% annual growth rate of RE [16]. Considering these factors we have assumed a growth rate of 10%, 15% and 20% for the pessimistic, likely and optimistic cases. Column (3) assumes three different CUF of 20%, 22% and 24% which is based on past year trends of actual energy generated corresponding to the respective RE installed capacity. Column 4 assumes the scenarios for share of REC in the total RE capacity addition viz. 25% (lower limit), 35% (likely) and 45% (upper limit) as discussed earlier while column (5) assumes a lower limit of Rs. 1500 (floor price), likely price of Rs. 2820 (weighted average price) and an upper limit of Rs. 3300 (forbearance price) of REC for the respective cases for forecasting the growth of REC mechanism in the short term.

6.2. Forecast of installed RE generation capacity

Fig. 9 shows the forecast of installed RE capacity for the next 5 years in the three considered cases of different AGR along with the MNRE targets for installed capacity addition.

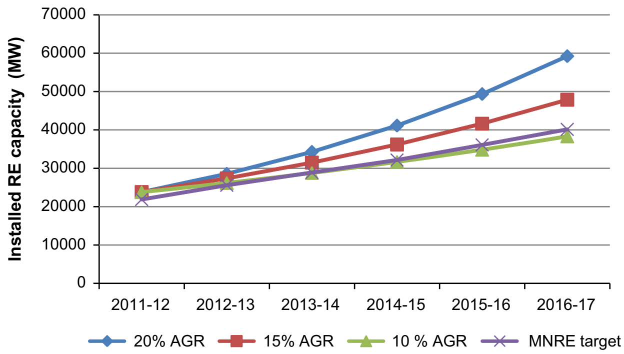


Fig. 9. Forecast of installed RE generation capacity (in MW).

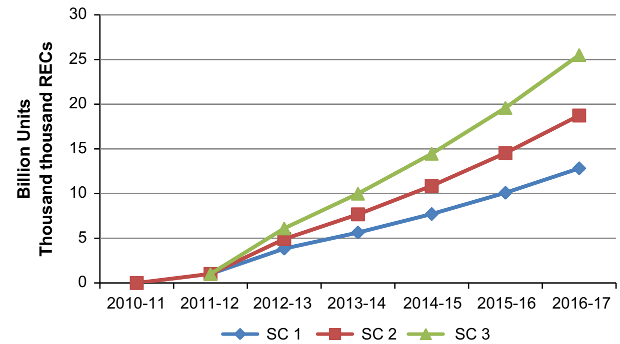


Fig. 11. Forecast of REC market volume for different scenarios.

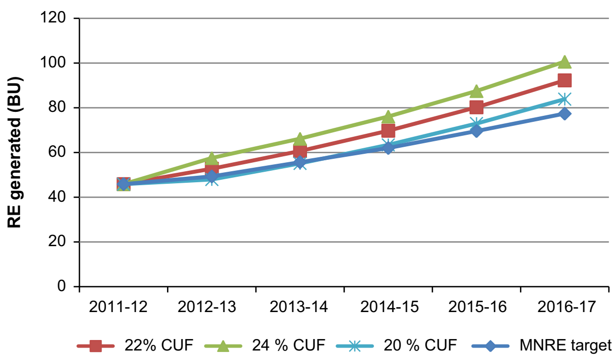


Fig. 10. Scenarios for RE generated (in BUs) for 15% AGR and varying CUF.

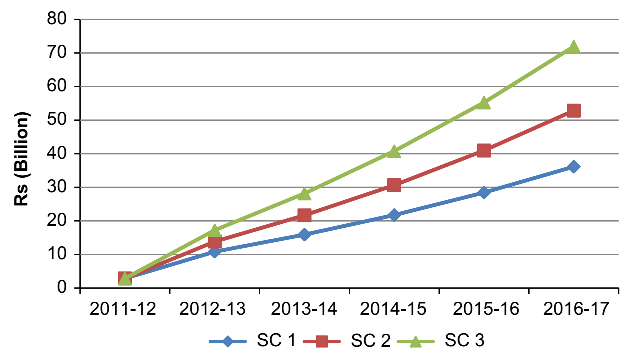


Fig. 12. Forecast of REC market size for different scenarios.

Table 4
Scenarios for forecasting the growth of REC market.

Growth rate of installed capacity	REC price	Scenario	CUF	Share of REC
15%	Rs 2820	**1**	20%	25%
15%	Rs 2820	**2**	22%	35%
15%	Rs 2820	**3**	24%	45%

Fig. 10 shows the total annual RE generated assuming the likely case of 15% AGR and thereafter using three different CUF of 20%, 22% and 24% as shown in Table 3. As shown in Fig. 10, the MNRE target of installed capacity addition with an assumed CUF of 24% corresponds to the lower end of the spectrum of the considered scenarios. It is therefore important that it should be revised upward in the near future to provide a further boost to the RE sector in India.

6.3. *REC market forecast*

Although various scenarios can be worked out using permutations and combinations of assumptions as given in Table 3, we prefer to freeze certain parameters so as to limit the spread of forecasted results. These forecasts can be replicated using other assumptions as defined by the user. Refer to Table 4, where we have assumed the various scenarios after fixing the growth rate of the installed capacity to 15% and the price of REC to Rs. 2820 per REC. Scenario 1 assumes a CUF of 20% and it is assumed that the share of projects via the REC route is 25% of the total capacity addition in the year. Scenarios 2 and 3 similarly assume a CUF of 22% and 24% and it is assumed that the share of projects via the REC route is 35% and 45% of the total capacity addition in RE generation respectively.

Using the scenarios as mentioned in Table 4, we derive the forecast for the REC market volume for the next 5 years which is shown in Fig. 11. Calculations under the assumed scenarios reveal that the REC market which is currently only 2.21% of the total RE market will have a share in a range of 7–11% in the year 2012–13 which will further rise to 11–22% for the year 2016–17.

The corresponding forecast of the market size as per these scenarios is shown in Fig. 12. The market size corresponds to a range of Rs. 10–17 billion for the year 2012–13 and is further forecasted to rise to Rs. 36–71 billion for the year 2016–17. It is therefore evident that the REC market is forecasted to grow substantially in the coming years as per our assumptions and calculated scenarios.

7. Discussion

7.1. *Advantages and disadvantages of REC mechanism*

REC mechanism has some additional advantages over existing arrangements to promote RE generation. It allows states endowed with RE to generate RE over and above their RPO and also allows states with low RE potential to set and fulfill higher RPO. REC mechanism relies on market forces to increase competition and create more liquid RE markets. It creates an incentive to develop the best RE resource first, thereby reducing the overall average cost of generation of RE in the country. Hence, optimal generation of RE ensures that RPO goals are met at the lowest possible cost. By avoiding physical transmission of electricity, it reduces congestion on the network, avoids additional transmission related costs and is devoid of complications of load-matching between seller and buyer in trading of physical electricity. It also gives an option of voluntary purchase of REC by the environmentally conscious customer, thereby generating additional demand of RE. This hastens the deployment of RE technology in the country.

There are certain disadvantages of REC mechanism which must also be highlighted to present a complete picture. REC trading encourages local generation and limits the growth of RE in a geographical region rather than widespread deployment of

technology. It does not overcome the problem of intermittency of electricity generated from RE and as the entire electricity has to be absorbed by the state specific entity (SEB). A high level of RE may create problems if correct estimation and generator scheduling is not undertaken. Insufficient market liquidity and absence of forward markets lead to price opacity which may further lead to market manipulation or use of market power by REC traders. Lastly, for the scheme to work it is imperative that the overall demand for REC should be greater than the existing RE generation in the country and REC markets only work where there are severe penalties for non-compliance, which is a cause of concern in India.

7.2. *Correcting market distortions*

There are various market distortions which affect the REC market and inhibit true price discovery of REC on the exchange. These include limited number of buyers and sellers, imperfect information, non-homogeneous products, low liquidity and lumping of REC purchase at the end of the FY. Hence the market design needs to be improved by taking appropriate amendments by the regulator. A few recommended measures for generating a buoyant REC market are indicated below.

7.2.1. *Steps to increase supply of REC*

(i) Allow off grid RE projects, projects less than 250 kW capacity and solar rooftop projects to be included as a part of REC mechanism by designing foolproof accounting measurement and verification of generated electricity.
(ii) Allow state owned DISCOMs and utilities to re-sell excess RECs in the market.
(iii) Enforce strict compliance of RPOs for OEs which would encourage RE developers and bankers for investing in this sector.

7.2.2. *Increasing demand of REC*

(i) Increase the RPOs of the states to confirm to the all India targets for RE as envisaged in the National Action Plan for Climate Change (NAPCC) [17].
(ii) Encourage development of a voluntary REC market wherein any individual or entity can purchase REC from the market to offset their carbon footprints without investing capital into generation capacities. This can be done by encouraging entities like corporate houses/CPSU to purchase REC on a voluntary basis. Infact, a positive step in this direction has already been taken by the Department of Public Enterprises (DPE) which has issued a notification in Dec 2011, by which voluntary purchase of REC can be undertaken under the head 'Energy management and promotion of RE' under the 'Guidelines on Sustainable Development for CPSEs'. A similar effort to include large corporate houses as voluntary buyers in the REC market under the 'Companies Bill', 2011 (which was tabled in the parliament on 14 Dec, 2011 and has recommended a 2% yearly spending on CSR activities by private listed companies) would definitely set the ball rolling in the right direction. Since voluntary purchase of RECs would help create a robust demand for RE, it would give correct market signals for investment in the RE sector.

7.2.3. *Reduce pricing risk*

(i) Reduce the compliance period of sale and purchase of RECs from annual to quarterly. This will discipline the OE to space out and plan its purchase of RECs over the year and would encourage regular trading of RECs on the exchange. Apart from avoiding hoarding of RECs and timing the market for speculative purposes by the RE generator, it would lead to better price discovery by averaging out the demand for RECs over the year. It would also provide regular cash flows to RE generators (especially biomass) and would lead to more bankable projects.
(ii) Introduce a vintage based REC to account for the reduction in capital investment as time increases. A suggested way to set this ratio is to consider the average weighted price of the REC for the past year. For e.g. if a project A is set up in 2010–11 and the average weighted price for an REC in 2010–11 is Rs. 3000, in 2011–12 is Rs. 2500, and in 2012–13 is 2000, then 1.2 RECs should be issued for each MWh of energy injected by the project A in 2012–13 and 1.5 RECs should be issued for each MWh of energy injected by the same project in 2013–14. This would effectively eliminate pricing and policy risk and would ensure constant revenue for the project developer, thereby increasing the bankability of the project.
(iii) In order to attain high growth rates of RE generation and to encourage a larger number of players in the sector, it is important that lending agencies develop innovative financing mechanisms to extend the lines of credit to relatively smaller RE producers by accounting for cash flows from selling of RECs. As the REC mechanism is relatively new, cash flows from market prices of RECs are still not accounted for while performing due diligence by lender. This affects the bankability of a new RE generation project. However, a proper risk assessment and structuring of REC as a credit enhancement product has a potential to emerge as a win–win solution to this dilemma for both[5] bankers and RE developers. Further, as more merchant power comes online, an increase in trading volumes on exchanges would eventually lead to increase in lender confidence in the REC mechanism. This vital link in the chain where future cash flows from RECs can be used to monetise advance sale of RECs for project financing, is still missing in the Indian energy finance context. This feedback effect which is presented in Fig. 13 will eventually lead to an increase in the share of RE generation in the future energy mix in India.
(iv) Any developed commodity or financial market should ideally function at two levels, a spot market and a derivatives market. Prices in spot markets send a clear signal about the supply/demand balance at the present moment while a futures market is designed as a financial mechanism and is essentially a zero-sum game. Here the risk is re-distributed among market participants according to their positions and appetites. Using a hedging strategy, both the supplier of RE and the OE can limit the uncertainty over price fluctuations and can aid in effective financial planning. The fear that futures market may be manipulated for speculative purposes are ill founded as having a forbearance price for REC will avoid excessive speculation but will effectively reduce pricing uncertainty and will give the right signals for investment in RE in the long term.
(v) In the long term, fungibility between REC, Energy Saving Certificates (ESCerts) and Certified Emissions Reduction (CER) markets needs to be considered as world over carbon markets are now moving towards triple convergence. Such a move will be symbiotic for strengthening of all emerging market mechanisms in India.

[5] while meeting the end goal of increase in RE generation for the policy maker.

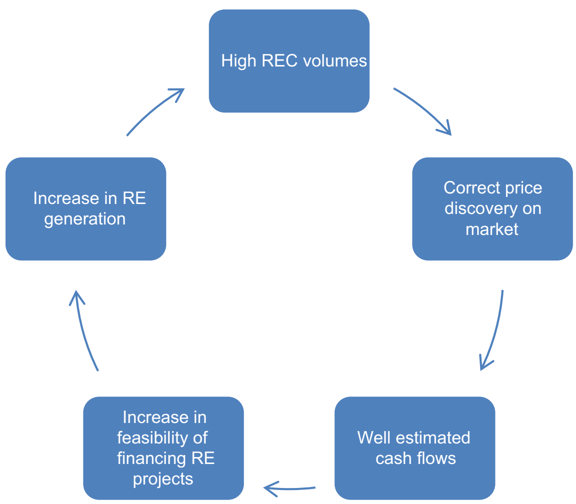


Fig. 13. Positive feedback cycle for increasing share of RE generation.

7.3. Contribution of REC mechanism to RE development in India

There are various factors which define the framework for RE markets, and can act as barriers or accelerators to the progress of RE deployment in a country. While 'policy' and 'regulation' play a major role in the development of the sector there are 14 other contextual factors which have been identified [18]. These are resource availability, technology availability, technology cost, energy costs, economic context, project financing options, ownership options, transmission infrastructure, institutional structures, social acceptance, environmental considerations, land-use constraints, information dissemination and larger policy context. Doris et al. [18] show that there are positive correlations between the total number of market transformation policies within a given state (including both barrier reduction and technology accessibility policies) and the total electricity generated from RE (MWh) within that state. Although all 14 factors influence the bottom-line economics for RE projects, there is a complex interplay between various contextual factors and the same contextual factors may affect states differently. In the specific context of India, the situation is further complicated by frequent changes in policy, weak enforcement and recent implementation of the REC regulatory framework. Hence it is an uphill task to quantify the impact of REC mechanism on the growth of RE development in the country. Notwithstanding the above, isolation of factors to quantify the impact of individual components can be attempted after few years of data on REC market is available. Further, an understanding of these mutual interactions among various contextual factors will also aid effective policy design and implementation in the future.

8. Conclusion

RECs trading sessions in the past few months have been encouraging and indicate that support and industry confidence in the REC mechanism is building up. Based on the above analysis we can conclude that REC is a deficit market and therefore a seller's market. Moreover, due to the seasonal nature of the RE sources, the market currently can be divided into two distinct parts. Although the determination of price of REC is based on economics of demand and supply, the market is yet to attain traction to throw up an optimal market clearing price. This can be attributed to limited number of players, low transaction volume and infrequent trading which has lead to a shallow market. Hence we avoid forecasting any MCP for the REC in the short term based on economic principles but based on the past 1 year price history of REC we can forecast that it is safe to assume a mean price of Rs. 2400 for FY 2012–17 (floor price Rs. 1500 and forbearance price of Rs. 3300 has been already declared). Lastly, one must not lose sight of the fact that, REC trading was essentially meant to be used as a facilitating mechanism for meeting the Renewable Purchase Obligation (RPO) in the compliance market, which would eventually encourage generation of electricity from RE sources. Hence one must guard against the vested interests of market participants such as RE developers, energy exchanges, power traders and OEs and the market should be regulated appropriately in order to encourage RE generation in the country.

The REC market has grown to an annual size of 2.86 billion INR in only 1 year. It is likely to grow manifold in the future provided adequate policy support and continuous corrections are given in the right direction. A thriving REC market would aid in promoting generation of RE across India, avoid carbon emission and would eventually contribute to strengthen energy security in the country. It is now left to the regulator to promote the REC market and to ensure strict compliance of RPOs, in order to meet the RE generation targets.

Table A1
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Region/states	Likely power generation as per 17th EPS	RPO obligation (latest)	RE required
Northern region	**(MU)**	**(%)**	**(MU)**
Chandigarh	1561	1.7	26.53
Delhi	34,581	1.9	657.04
Haryana	33,777	1.13	381.68
Himachal Pradesh	9236	11	1015.96
J&K	10,631	2.9	308.29
Punjab	42,349	2.37	1003.67
Rajasthan	45,672	9.5	4338.84
Uttar Pradesh	62,975	4.5	2833.87
Uttarakhand	8363	10	836.3
Western region			
Chhattisgarh	28,697	5	1434.85
Gujarat	74,838	5.5	4116.09
Madhya Pradesh	41,972	2.1	881.41
Maharashtra	101,123	6.75	6825.80
Daman & Diu	1903	1.7	32.35
D.N. Haveli	4696	1.7	79.83
Goa	3008	1.7	51.13
Southern region			
AP	77,608	4.75	3686.38
Karnataka	55,256	7	3867.92
Kerala	16,689	3.3	550.737
TN	71,767	9	6459.03
Puducherry	2494	1.7	42.39
Eastern region			
Bihar	11,210	2	224.2
DVC	16,668	3	500.04
Jharkhand	6540	2.5	163.5
Orissa	21,511	4.9	1054.04
West Bengal	40,421	3	1212.63
Sikkim	944	NA	0
North Eastern region			
Arunachal	589	NA	0
Assam	6021	2.8	168.58
Manipur	588	2.75	16.17
Meghalaya	1652	0.45	7.43
Mizoram	408	5.75	23.46
Nagaland	597	6.75	40.29
Tripura	1029	0.9	9.26
All India	837,374		**42849.76**

Acknowledgements

This work has been undertaken as a part of my Ph.D. research and I gratefully acknowledge the support of Dr. B. Sudhakara Reddy under whose guidance this work was undertaken.

Appendix A

See Appendix Table A1.

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